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EFFECTS OF TRAFFIC VOLUME ON WILD BIRDS AND DIVERSITY INDICES IN AWBA LAKE ENVIRONMENT, UNIVERSITY OF IBADAN, IBADAN, NIGERIA

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ABSTRACT

Daily disturbance attributed to traffic volume is believed to be an important factor determining bird population and activity in habitats with close proximity to roads. Nevertheless, not all bird species respond negatively to traffic volume. The effects of traffic volume on the distribution of birds in the Awba Lake Environment was investigated using line transects method between April and June 2014. The study area was stratified based on land use types into four sites, namely; construction site, dense, sparse habitat and road sites. A total of 10 transects measuring 300-500m were purposively laid across the four sites. All counts were made in early mornings (0700-1000 hours) and evenings (0400-0600 hours). All birds seen or heard were identified and recorded to their species. The data collected were analyzed using Analysis of Variance and Shannon-Winner diversity Index. A total of 306 individuals were recorded, divided in to 43 species belonging to 28 families. The Shannon diversity index revealed a moderate (H' 2.7806) species diversity and the mean bird species diversity did not vary with sites. The findings also revealed a higher detection of Cattle Egret and Longtailed cormorant more than any other species in the area. Time of the day significantly affected bird species diversity and richness across the sites. For further research; it might be useful to classify all the birds in Awba Lake Environment according to the frequency range of their vocalizations so that comparisons between species can be made with regard to their response to traffic volume.

Keywords: Birds; Road; Diversity; Traffic; Richness

INTRODUCTION

Awba dam was chosen by the management of the University of Ibadan for expansion to a tourist center of international standard in 2013. The project could result in increase in pressure on habitat and bird species due to vehicular movement in the area. However, roads can't be built without removal of vegetation which provides food and shelter to species occupying the area. Traffic volume from vehicles operating in the area and those passing through the lake site may have some effects on wild birds and some indices of diversity in the area. Traffic volume is believed to be the most important factor affecting breeding bird population densities near roads (Reijnen and Foppen, 2006). Traffic can influence occupancy levels (Clec'h, 2001) and create avoidance zones that extend as far as 1000 m or more from theroad (Reijnen and Foppen, 2006)but not all bird species respond negatively to traffic (Kaseloo 2005, Reijnen and Foppen 2006). For those that are negatively affected, however, population losses within avoidance zones can range from 30 %to almost 100 % (Reijnen and Foppen, 2006).

Open habitats appear more prone to this detrimental effect than closed habitat types and may help explain the decline in grassland birds over the past few decades (van der Zande *et al.* 1980, Forman *et al.* 2002). Awba lake environment may not be exception to this. Perhaps one important contribution to the current knowledge of traffic impacts on birds was research which revealed that the density of male Willow Warblers was lower in the road zone (0–200 m from the road) than in similar habitat farther from the road (Reijnen and Foppen 1994, Foppen and Reijnen 1994). There are multiple emissions from traffic that might explain its density-depressing effect, including pollution, road kills, visual disturbance, and mechanical vibration, but traffic noise is probably the most influential at larger distances (van der Zande *et al.* 1980, Forman *et al.* 2002; Reijnen and Foppen 2006). While traffic noise is suspected to be the major cause for decreased breeding bird diversity and density near roads, there may be confounding factors such as edge effects (Habib *et al.*, 2007). Direct evidence that chronic anthropogenic noise negatively impacts bird populations is lacking but there is increasing evidence (Habib *et al.,* 2007; Slabberkoorn and Ripmeester, 2008). In a study that isolated chronic industrial noise from other potential confounding variables, ovenbirdpairing success and age structure were affected by traffic volume (Habib *et al.* 2007).

In general, traffic volume and associated noise can affect certain breeding bird densities in woodland and grassland habitats near roads (Kaseloo 2005). Slabberkoorn and Ripmeester (2008) list mitigation measures (e.g., physical noise barriers and temporal adjustments to traffic flow) that may help abate noise for the benefit of humans and birds.

MATERIALS AND METHODS

Study Area

Awba Lake is located in the University of Ibadan, Ibadan, Oyo State, Nigeria, about 160 km from the Atlantic Ocean coast. It lies on latitude 7º 26' North and longitude 3º 53' East at an altitude of 208m above sea level. Ibadan exhibits the typical West African Monsoon climate marked by distinct seasonal shifts in wind patterns. Between March and October, the city is under the influence of moist maritime south west monsoon winds which blow inland from the Atlantic Ocean, marking the rainy season. The dry season occurs from November to February when the dry dust laden winds blow from the Sahara desert. The

area experiences high relative humidity and generally two rainfall maxima regimes during the rainfall period of March to October. The mean temperatures are highest at the end of the Harmattan (averaging 28°C), that is from the middle of January to the onset of the rains in the middle of March. Even during the rainfall months, average temperatures are relatively high, between 24°C and 25°C, while annual fluctuation of temperature is about 6°C. Most areas of Ibadan are covered by the rain forest and derived savannah (Ajayi *et al* 2012).

Awba Lake is an earth dam originally constructed in 1994 in Ibadan, Nigeria, to enhance water supply to Ibadan University Community, as well as for fish production and research purposes. The current capacity of the reservoir is 227 million litres of water, with a surface area of 6 hectares and depth of 5.5 m, hence, its relevance to the host community cannot be underestimated. The water of the Lake is sill with multi-directional water movement due to wind effects. Wind action in the Lake is minimal in the dry season and the high temperatures at this period result in thermal stratification of the water.

Sampling and Birds' Count

The study area was stratified by land use types into four namely:

1. Dense habitat: areas that were thickly covered by trees, shrubs and grasses with over 70% crown cover and 30% ground cover
2. Sparse habitat: areas with 50% crown cover with scattered trees, shrubs and grasses
3. Construction site: Site undergoing construction work
4. Road area: Ten transects were laid on the major roads in the Awba lake environment.

Bird count was done using the line transect method. This involves an observer moving slowly along transects and recording all birds detected on either side of transects. A total of 10 transects, each ranging between 200-300m was randomly located in the study site.

A Geographic positioning system (GPS) was used to mark out start and end points of each transect. Transects were laid adjacent to road corridor and a minimum distance of 200 mwas ensured between transects. Each transect was visited twice from April to June, 2014. All counts were made in early mornings (0700-1000 hours) and evenings (0400-0600 hours). To avoid double count, only birds within the radius of 50m from the transect line were recorded. All birds seen or heard were identified to species with the aid of a pair of binoculars and field guide to the birds of western Africa (Borrow and Demey, 2013). In addition, perpendicular distances of counted birds estimated to the transect line was recorded.

Data Analysis

SPSS (Statistical package for social sciences, version 11, 2001) software package was used for statistical analysis. Bird species diversity was calculated using Shannon-Winner diversity index (H), in the equation below:

$$H = -\sum Pi * lnPi$$

Where Pi is the proportion of individual species in the sample, and lnPi is the natural logarithm of this proportion while S is the total number of species in the community (number seen plus number heard) (Kathleen and Callahan, 2005). Average bird diversity

was calculated by getting a mean of the sum of (replicated surveys) birds in each transect for morning and evenings in the study area. One-–way ANOVA was used to determine if the mean differences between land use types were significant.

Determination of Encountered Rate and Relative abundance:

The encountered rate was calculated using the procedure adopted by Tanko and Ivande (2011) as follows:

$$ER = \frac{X}{Y} X\ 100$$

Where: ER= encountered rate, X=number of birds encountered, Y=time taken to record them, 10=standardizing factor.

Relative abundance of the species was placed into categories as shown below;
<5=uncommon, 6-10=common, 11-20=frequent, >20=abundant (table 4)

RESULTS AND DISCUSSION

Effect of Land Use Types on Bird Species Diversity

Land use types type had no significant effect on species diversity but a trend was obvious. The overlapping error bars observed in figure 1 revealed that dense habitat is significantly different from construction site but statistically the same with other Land use types. The differences observed between dense habitat and construction site may not be unconnected with habitat destruction as a result of ongoing construction work in the study site). However, the differences in species frequency at each site might reveal some of the differences veiled in using species diversity to show effect of land use on the environment.

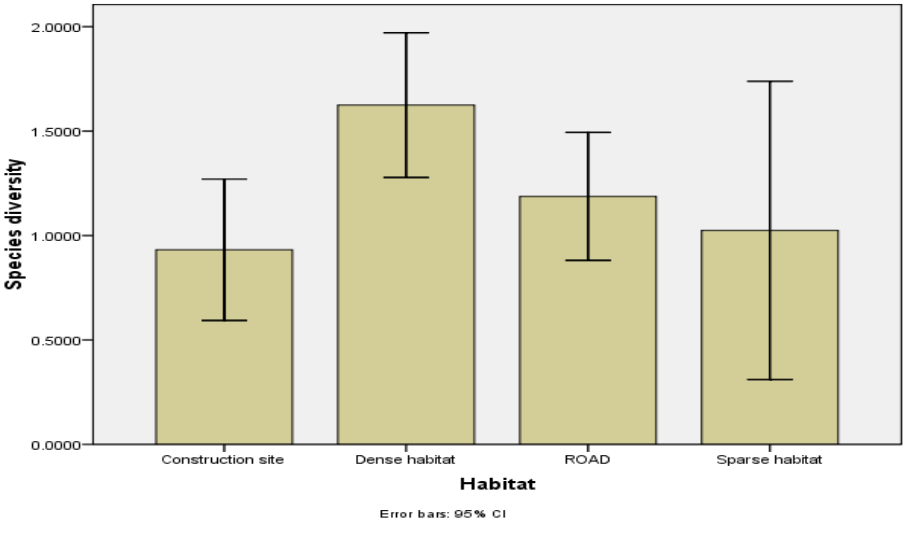

Figure 1: Observed mean bird diversity across sites

Effects of traffic Volume, Speed and Time of the Day on Diversity and Abundance of Species across Sites

None of the interaction terms were significant in determining the diversity of birds in Awba Lake environment (Table 1 and 2). Kaseloo (2005) concludes that traffic volume and associated noise affected negatively certain breeding bird densities in woodland and grassland habitats near roads. Results for mean diversity and abundance in this study do not provide support for the latter and this could be attributed to other confounding factors such as edge effect (Habib *et al*. 2007). According to Ingelfinger and Anderson (2004), traffic volume alone may not fully explain reduced passerine population densities near road networks in some situations where habitat fragmentation, edge effects, and changes in community structure may also be playing a role. This might be the reason why none of the interaction terms was found to have significant effect on the species diversity in the study area.

Table 1: UNIANOVA test between traffic volume (Cars per day), average speed and distance of species from road (Dependent variable: mean bird diversity)

Source	Type III Sum of Squares	df	Mean Square	F	P-value
Corrected model	3.873	3	1.291	0.653	0.584
Intercept	19.987	1	19.987	10.107	0.002
Species distance	3.272	1	3.272	1.654	0.203
Cars	0.316	1	0.316	0.160	0.691
Average speed	6.521E-5	1	6521E-5	0.000	0.995
Error	136.456	69	1.978		
Total	461.456	73			
Corrected total	140.329	72			

Table 2: UNIANOVA test between speed, number of motorcycles, species distance to transect line, number of cars and time of day (Dependent variable: Abundance)

Source	Type III Sum of squares	df	Mean square	F
Corrected model	4.893	5	0.979	0.552
Intercept	0.112	1	0.112	0.63
Average speed	0.979	1	0.979	0.552
Motorcycles	0.237	1	0.237	0.133
Species distance	0.0911	1	0.0911	0.616
Number of Cars	0.856	1	0.856	0.483
Time of day	3.072	1	3.072	1.733
Error	93.955	53	1.733	
Total	347.000	59		
Corrected total	98.847	5		

R squared=0.49 (Adjusted R squared=0.40)

Effect of Time of Day on Species Diversity and Richness in Awba Lake Environment

Time of day was significant in determining bird species diversity across the sites (Table 3). That is, morning and evening detection are not the same, implying that as time of day progressed, average bird diversity reduced. More bird species were sighted in the morning than in the evening and therefore species richness was also higher in the morning than evening. However, this is expected, because many studies have shown that bird activity is known to be higher in the morning than in the evening (Adeyanju *et al*., 2011, Manu *et al.*, 2007). This has been explained to be due to a reduction in bird activity as time of the day progresses.

Table 3: One-way ANOVA for the effect of time of day on mean bird diversity and richness in Awba lake environment

Source	Sum of Squares	df	Mean Square	P-value
Between Groups	2.099	1	2.099	0.011
Within Groups	11.049	38	0.29	
Total	13.149	39		

Table 4: Checklist of wild birds encountered in Awba Lake environment

Family	*Scientific Name*	Species	Average Mean of occurrence	Index of Abundance
Phalacrocoracidae	*Phalacrocorax africanus*	Long-tailed cormorant	37	A
Ardeidae	*Ardeola ralloides*	Squacco Heron	2	U
Ardeidae	*Bubulcus ibis*	Cattle Egret	111	A
Ardeidae	*Butorides striata*	Striated Heron	4	U
Ardeidae	*Ardea melanocephala*	Black-Headed Heron	3	U
Anatidae	*Dendrocygna viduata*	White-faced duck	3	U
Accipitridae	*Milvus migrans*	Yellow-Billed Kite	6	F
Accipitridae	*Urotriorchis macrourus*	Long tailed Hawk	1	U
Phasianidae	*Francolinus bicalcaratus*	Double-spurred Francolin	4	U
Rallidae	*Amaurornis flavirostra*	Black crake	1	U
Jacanidae	*Actophilornis africana*	African Jacana	4	U
Charadriide	*Vanellus albiceps*	White Headed lapwing	2	U
Charadriide	*Vanellus spinosus*	Spur-winged lapwing	2	U
Columbidae	*Columba guinea*	Speckled Pigeon	3	U
Columbidae	*Streptopelia semitorquata*	Red eyed dove	7	F
Columbidae	*Streptopelia senegalensis*	Laughing dove	4	U

Musophagidae	*Crinifer piscator*	Western Grey Plantain eater	6	F
Cuculidae	*Chrysococcyx klass*	Klaas's cuckoo	1	U
Cuculidae	*Centropus senegalensis*	Senegal coucal	4	U
Caprimulgidae	*Caprimulgus climacurus*	Long-tailed night jar	1	U
Alcedinidae	*Halycyon senegalensis*	Woodland kingfisher	6	F
Coraciidae	*Eurystomus glaucurus*	Broad-Billed Roller	3	U
Phoeniculidae	*Phoeniculus purpureus*	Green wood-hoopoe	4	U
Bucerotidae	*Tockus fasciatus*	African Pied Hornbill	1	U
Bucerotidae	*Tockus nasutus*	African Grey Hornbill	3	U
Motacillidae	*Motacilla flava*	Yellow wagtail	4	U
Motacillidae	*Motacilla aguimp*	African Pied Wagtail	2	U
Motacillidae	*Macronyx croceus*	Yellow-throated longclaw	3	U
Pycnonotidae	*Pycnonotus barbatus*	Common bulbul	10	F
Turdidae	*Turdus pelios*	African Thrush	4	U
Muscicapidae	*Ficedula hypoleuca*	Pied flycatcher	2	U
Monarchidae	*Terpsiphone rufiventer*	Red bellied Paradise fly catcher	2	U
Nectariniidae	*Cinnyris coccinigastrus*	Splendid Sunbird	2	U
Nectariniidae	*Cinnyris cupreus*	Copper Sunbird	4	U
Laniidae	*Corvinella corvina*	Yellow-Billed Shrike	6	F
Dicruridae	*Dicrurus modestus*	Velvet Mantled Drongo	14	C
Corvidae	*Corvus albus*	Pied crow	3	U
Corvidae	*Ptilostomus afer*	Piapiac	4	U
Sturnidae	*Lamprotornis splendidus*	Splendid glossy starling	6	F
Ploceidae	*Ploceus cucullatus*	Village weaver	2	U
Ploceidae	*Malimbus scutatus*	Red vented malimbe	1	U
Ploceidae	*Malimbus rubricollis*	Red Headed Malimbe	7	F
Estrildidae	*Spermestes cucullatus*	Bronze manikin	7	F

Source: Field Survey, 2014, U=Uncommon, C=Common, F=Frequent, A=Abundance

Shannon Diversity Index and Encounter rate of Wild birds

The Shannon diversity index value for wild birds in Awba Lake Environment was found to be 2.7806 as indicated in table 5 above. Wild birds play significant role in human life and also serve as a key indicator of habitat health and conditions. Depending on the availability of species in an ecological zone, the diversity indices varies with location and habitat composition. This implies that habitat structure plays a significant role in dictating species diversity. The habitat of the study area has been altered as a result of the ongoing

construction work and this may be partly responsible for the diversity index obtained in the area. However, the diversity index value obtained in this study shows that Awba Lake environment is blessed with moderate diversity (2.7806) which lies within the general limit of 1.5-3.5.

Moreover, the results of the study further revealed a higher detection of *Bubulcus ibis* more than any species followed by *Phalacrocorax africanus* with average mean of occurrence (111 and 37) respectively. The high detection of the two species may not be unconnected with the habitat requirement of the species and partly their ability to withstand traffic intensity. The findings also revealed low detection of species such as *Malimbus scutatus, Caprimulgus climacurus Chrysococcyx klass* and *Amaurornis flavirostra* . The low detection recorded could be use to explain that their population is affected by the reduction of canopy cover as a results of ongoing construction work in the area.

Table 5: Shannon Diversity Value (*H'*) Index for Wild birds

Species	N	P*i*	lnP*i*	-P*lnP*i*
Phalacrocorax africanus	37	0.120915033	-2.112667189	0.255453222
Ardeola ralloides	2	0.006535948	-5.030437921	0.032878679
Bubulcus ibis	111	0.362745098	-1.014054901	0.367843444
Butorides striata	4	0.013071895	-4.337290741	0.056696611
Ardea melanocephala	3	0.009803922	-4.624972813	0.045342871
Dendrocygna viduata	3	0.009803922	-4.624972813	0.045342871
Milvus migrans	6	0.019607843	-3.931825633	0.07709462
Urotriorchis macrourus	1	0.003267974	-5.723585102	0.018704526
Francolinus bicalcaratus	4	0.013071895	-4.337290741	0.056696611
Amaurornis flavirostra	1	0.003267974	-5.723585102	0.018704526
Actophilornis africana	4	0.013071895	-4.337290741	0.056696611
Vanellus albiceps	2	0.006535948	-5.030437921	0.032878679
Vanellus spinosus	2	0.006535948	-5.030437921	0.032878679
Columba guinea	3	0.009803922	-4.624972813	0.045342871
Streptopelia semitorquata	7	0.022875817	-3.777674953	0.086417401
Streptopelia senegalensis	4	0.013071895	-4.337290741	0.056696611
Crinifer piscator	6	0.019607843	-3.931825633	0.07709462
Chrysococcyx klass	1	0.003267974	-5.723585102	0.018704526
Centropus senegalensis	4	0.013071895	-4.337290741	0.056696611
Caprimulgus climacurus	1	0.003267974	-5.723585102	0.018704526
Halycyon senegalensis	6	0.019607843	-3.931825633	0.07709462
Eurystomus glaucurus	3	0.009803922	-4.624972813	0.045342871
Phoeniculus purpureus	4	0.013071895	-4.337290741	0.056696611

Tockus fasciatus	1	0.003267974	-5.723585102	0.018704526
Tockus nasutus	3	0.009803922	-4.624972813	0.045342871
Motacilla flava	4	0.013071895	-4.337290741	0.056696611
Motacilla aguimp	2	0.006535948	-5.030437921	0.032878679
Macronyx croceus	3	0.009803922	-4.624972813	0.045342871
Pycnonotus barbatus	10	0.032679739	-3.421000009	0.111797386
Turdus pelios	4	0.013071895	-4.337290741	0.056696611
Ficedula hypoleuca	2	0.006535948	-5.030437921	0.032878679
Terpsiphone rufiventer	2	0.006535948	-5.030437921	0.032878679
Cinnyris coccinigastrus	2	0.006535948	-5.030437921	0.032878679
Cinnyris cupreus	4	0.013071895	-4.337290741	0.056696611
Corvinella corvina	6	0.019607843	-3.931825633	0.07709462
Dicrurus modestus	14	0.045751634	-3.084527772	0.141122186
Corvus albus	3	0.009803922	-4.624972813	0.045342871
Ptilostomus afer	4	0.013071895	-4.337290741	0.056696611
Lamprotornis splendidus	6	0.019607843	-3.931825633	0.07709462
Ploceus cucullatus	2	0.006535948	-5.030437921	0.032878679
Malimbus scutatus	1	0.003267974	-5.723585102	0.018704526
Malimbus rubricollis	7	0.022875817	-3.777674953	0.086417401
Spermestes cucullatus	7	0.022875817	-3.777674953	0.086417401
Total	306	1		2.78056434

CONCLUSION

Findings of this study revealed no significance effect of traffic volume on diversity indices (species richness and abundance) across the sites. The study therefore found that the area is stuffed with important species of birds that are moderately distributed. The findings also revealed a higher detection of Cattle Egret and Longtailed cormorant more than any other species in the area. The low detection of other species could mean that their population is either affected by traffic volume or reduction of canopy cover (or both) as a result of ongoing construction work in the area. The findings shows conservation significance of the area in terms of the number of species detected. It is therefore recommended that more warning signs and bumps need to be put in place to look at possibility of reducing the menace and future detection of vehicle-bird collision in the area. The habitat of the area should be upgraded, with effort to improving the species diversity.

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